Shared Control Demonstration for Unmanned Systems

2003

Naval R&D Partnership Conference

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Background

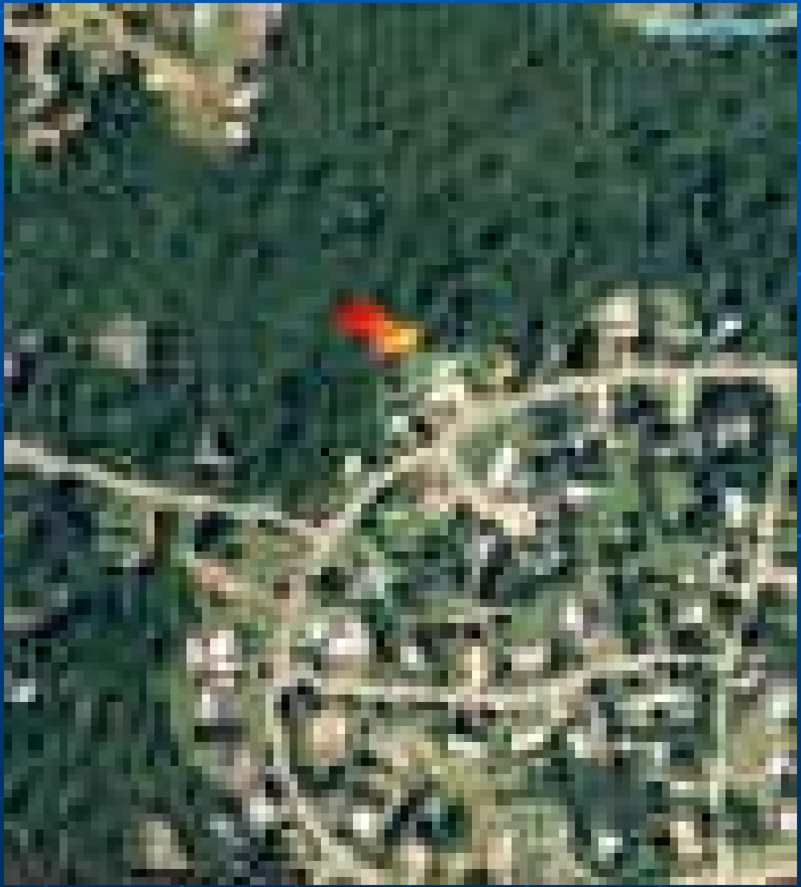
- Scientist Helping America Conference March 2002
  - Purpose: Bring members of the U.S. Special Forces with recent problems experienced in Afghanistan together with invited scientists, engineers and academics who may have answers to these problems
  - Sponsored by ONR, DARPA and U.S. Special Forces Command

The Problem

- Special Forces units on the ground and UAV operators have two different aspect views of the same thing
  - Ground units must try to talk UAV controllers onto a target of interest
  - If successful, UAV operators try to describe what they see back to ground forces
  - Ground Forces can not take direct advantage of the UAV video
  - Radio communication is not desirable for covert, special operations

Same Place, Different Aspects

Ground View



Aerial View

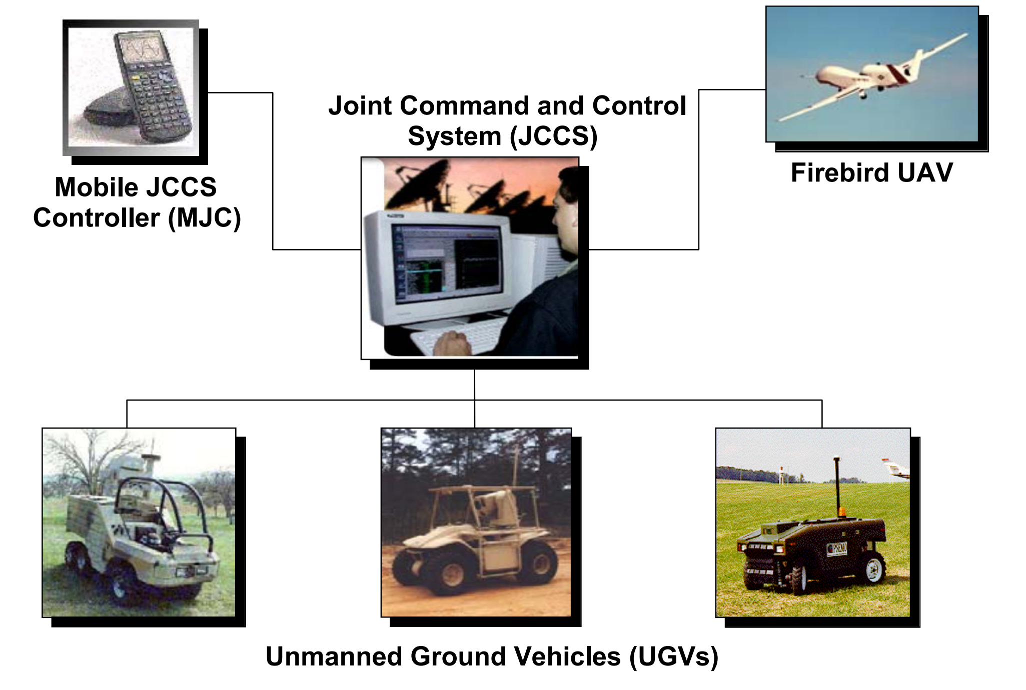
Special Forces Requirements

- Direct support from UAVs
  - Real time video
  - Control
    - Minimal Training Requirements
    - Minimal Currency Training Required
  - **No weight addition to ground forces!!**
    - Current U.S. Special Operations soldier carries average weight of approximately 125 lbs.

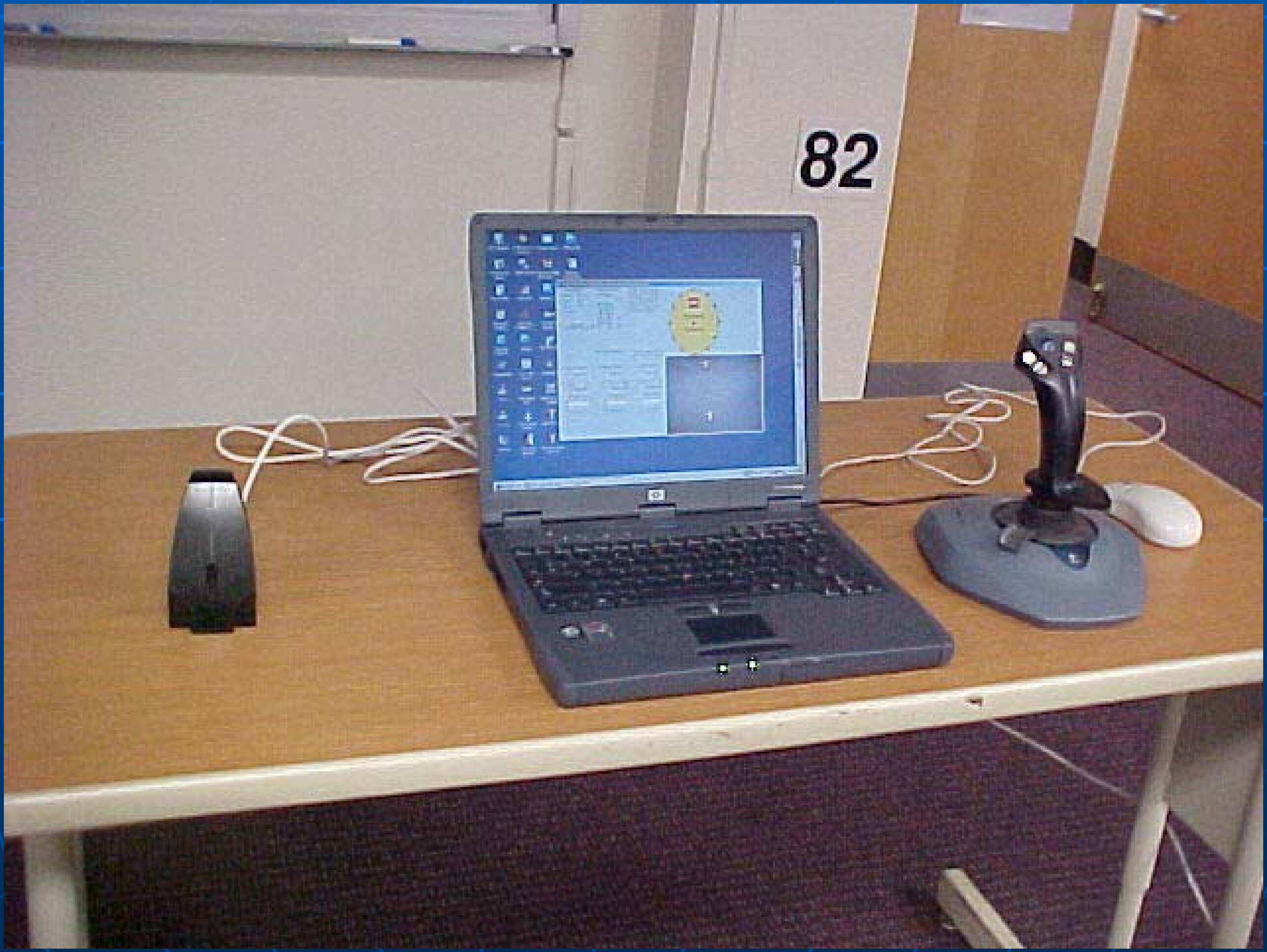
Shared Control Concept

- DAU developed a likely future based program scenario for its new level III program managers course
  - System of systems concept called the Joint Reconnaissance and Autonomous Targeting System (JRATS)
    - Integrated semi-autonomous unmanned air and ground vehicles controlled by two joint control systems
      - Shelter-based controller capable of long range control of multiple air and ground vehicles
      - Portable control unit for line-of-site control by ground forces at the front

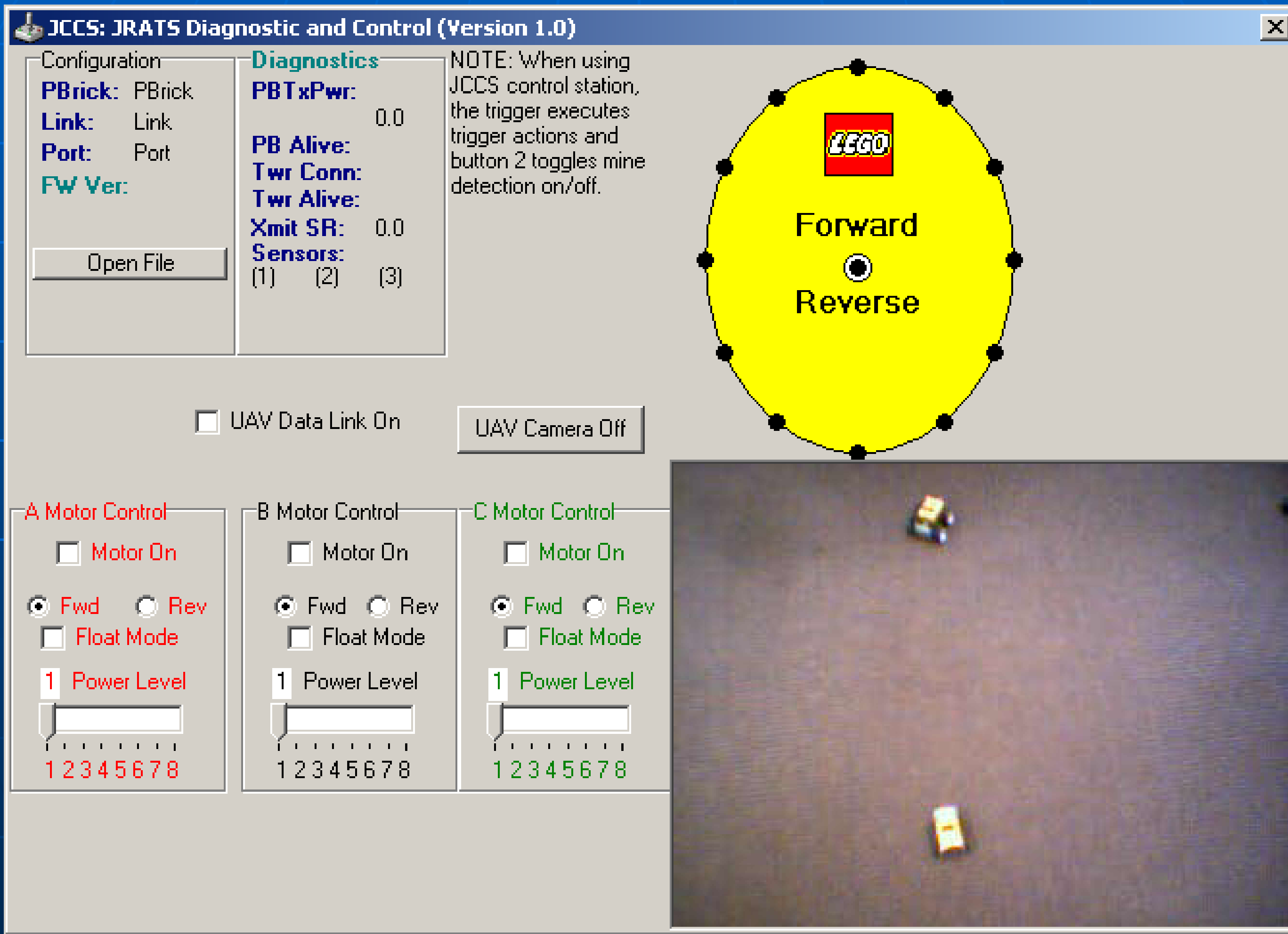
Joint Reconnaissance and Autonomous Targeting System



Joint Command & Control Station
Classroom Simulator



Control Screen



Hand-Held Control Units

Photo taken at 2002 ONR Cooperative Robotics Search and Rescue Exercise

Shared Control Project

- Sponsored by Office of Naval Research
- Jointly Executed by Defense Acquisition University and the U.S. Naval Academy
- Advanced Technology Demonstration using all commercial, off-the-shelf technologies
  - Demonstrate real time video display on computer screen
  - Demonstrate line-of-site unmanned vehicle control using simple computer interface

US Naval Academy 2002-2003 Helicopter Surveillance System

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MIDN 1/C Lee

MIDN 1/C Sisco

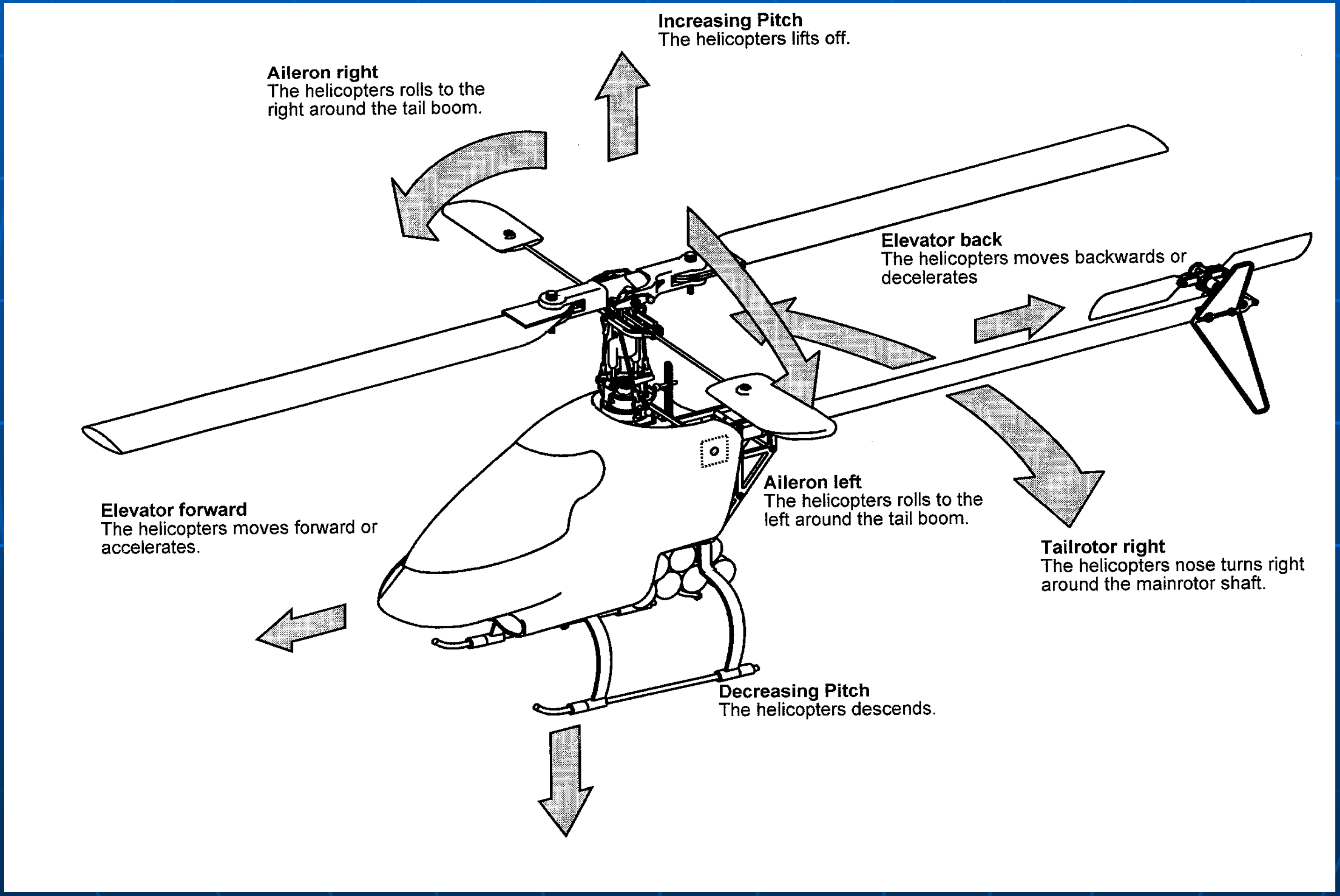
USNA Project Requirements

- Control must be local and simplified
- Must integrate technology already carried by troops in the field
- Must not compromise location of soldiers

COTS Implementations

ECO 8 & Piccolo RC Helicopters

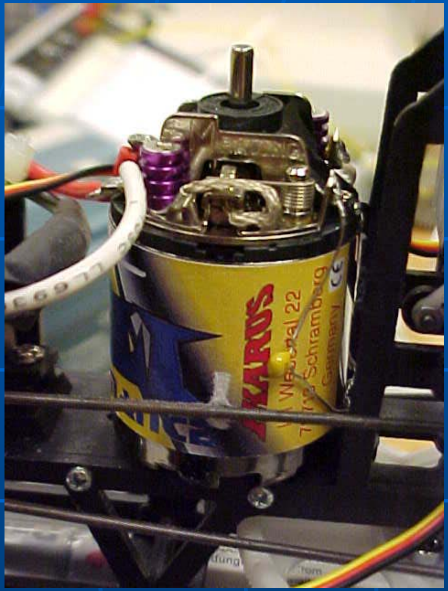
Helicopter Dynamics

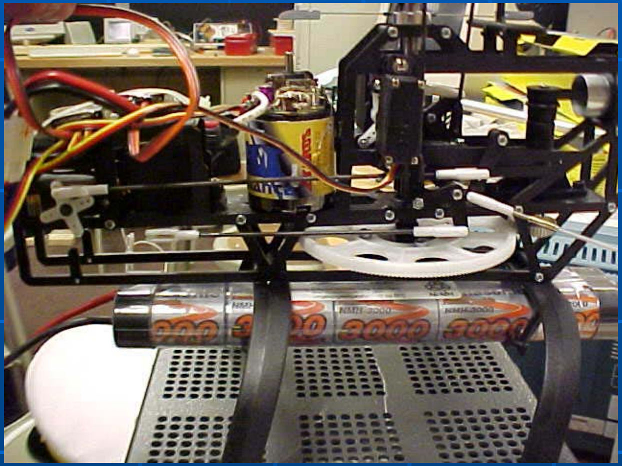


Power Source

- 12 Volt Rechargeable battery
  - 10 cell battery
  - Motor for Main Rotor and Tail Rotor System
  - 4 Servomotors
    - Roll
    - Pitch
    - Elevation
    - Yaw

Actuators





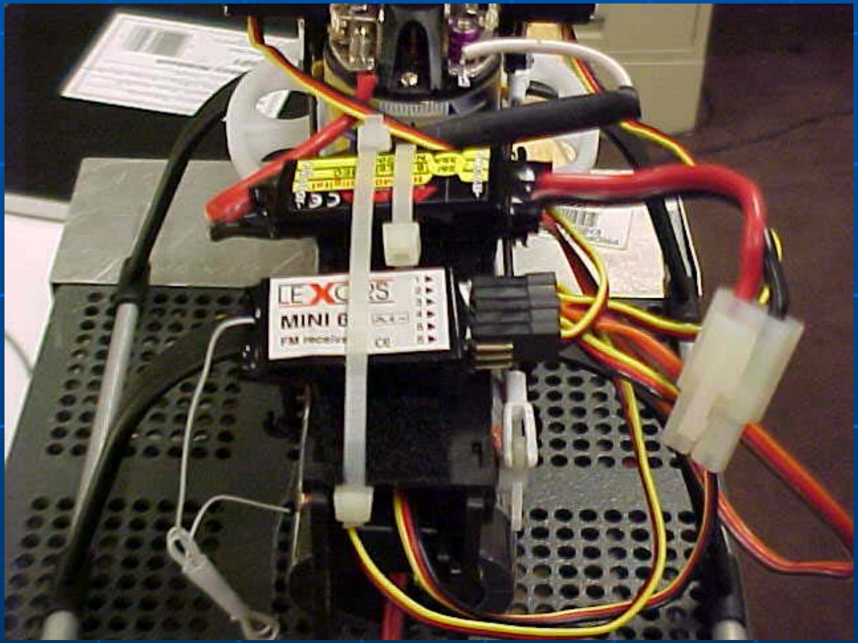
Main Rotor System: DC Performance Motor
13-14 minutes flying time with 10 cell battery
3.2 mm shaft diameter

Control System: 4 Servomotors

Roll	Yaw	*Torque: 3 kg/cm, more than enough
Pitch	Elevation	

Control Interface

- Electronic Speed Controller
  - Throttle
  - Pulse Width Modulation
- 6 Channel Reciever
  - Control / Power Supply to Servos
- Gyro
  - Decrease yaw rate



Air-born Video Camera/Transmitter/Receiver Kit

Technical Specifications

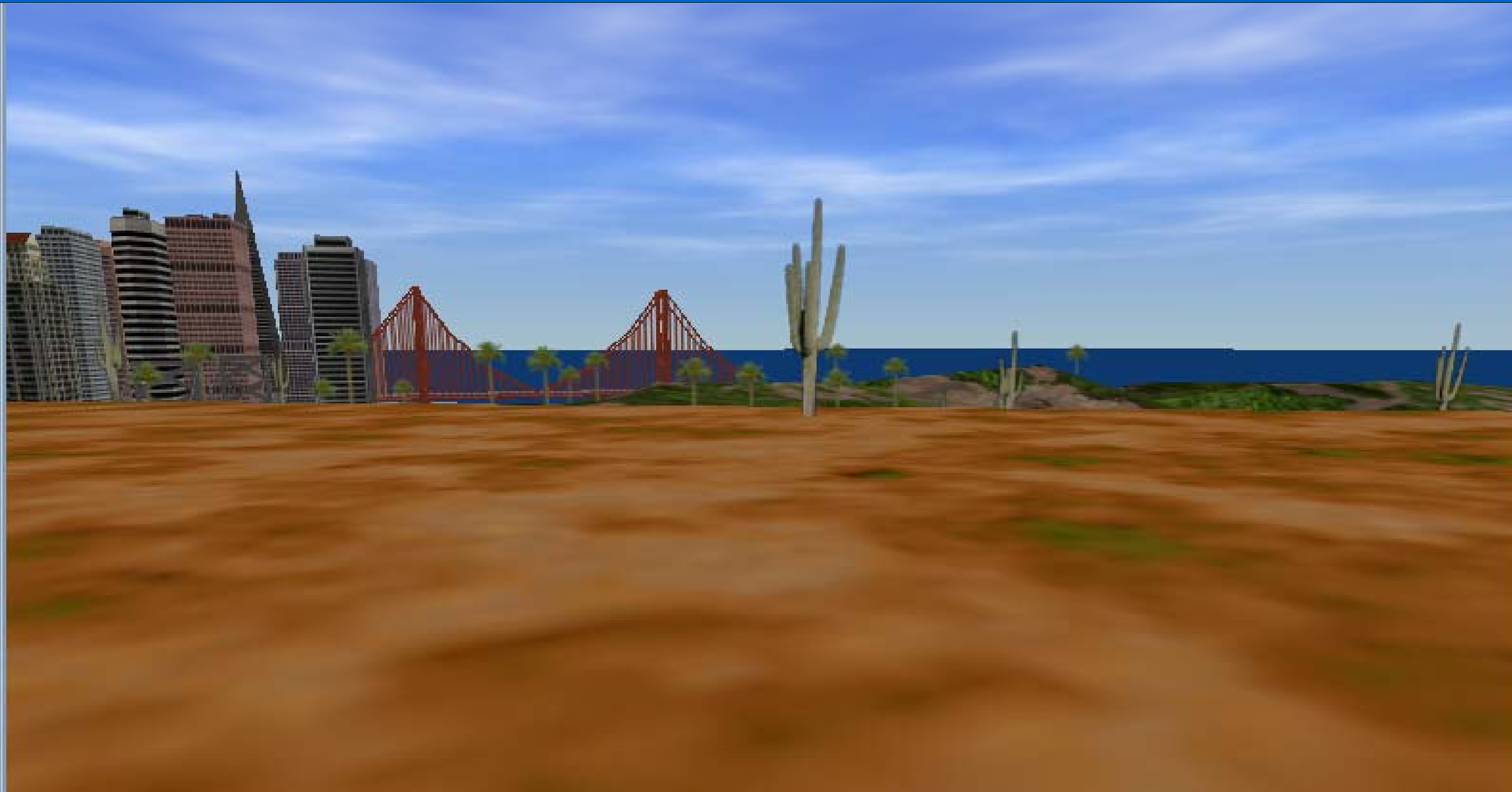
- Eyecam CMOS Color Camera / Transmitter
  - **Resolution:** 380 x 250 pixels
  - **Field Angle:** 92 degrees
  - **Size:** 15x15 mm, board lens
  - **One Channel:** 2.4 GHz Frequency band
  - **Operating Power:** DC 4.8-7.2 V, regulated
  - **Power Consumption:** 100 mA
  - **Antenna:** Omni-directional
  - **Transmitting Range:** 300 M (line-of-sight)
  - **Weight:** 16 grams
  - **Temperature:** -10 to +50 °C

Technical Specifications (cont.)

- Eyecam Receiver
  - **Frequency:** 2.4 GHz frequency band
  - **Antenna:** 60 degree directional
  - **Operating Power:** DC 12 V, regulated
  - **Power Consumption:** 180 mA
  - **Size:** 150x88x40 mm

Proposed Future User Interface

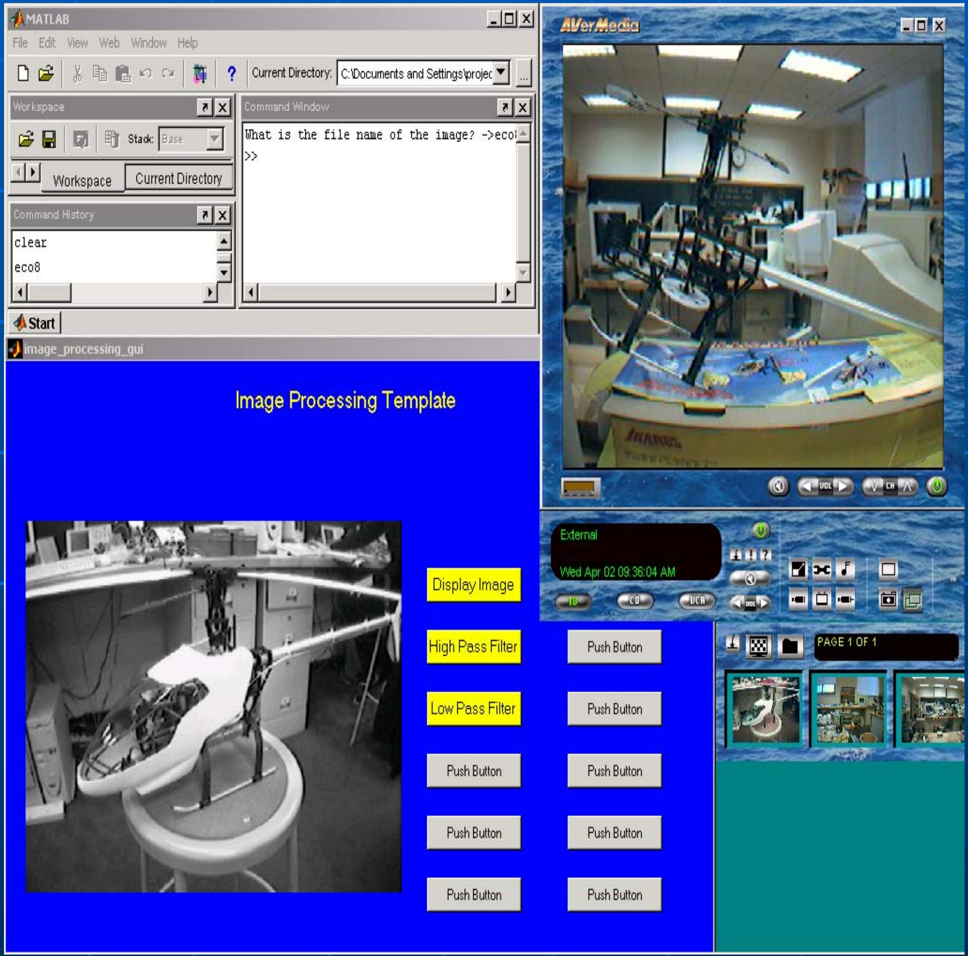
- Flight Data
  - Height/Altitude
  - Speed
  - Course
  - Flight time left
- View from Camera
  - Ability to take picture
    - Previous Pictures taken
    - Ability to process pictures post-flight



Altitude: 10 ft
Height: 8 ft
Speed: 6 mph
FTL: 8 min
Course: 336 deg

User Interface Under Development

- Uses MATLAB for computer vision processing
- Multiple windows can be open including:
  - MATLAB GUI
- - Real-time camera view



Vision Processing

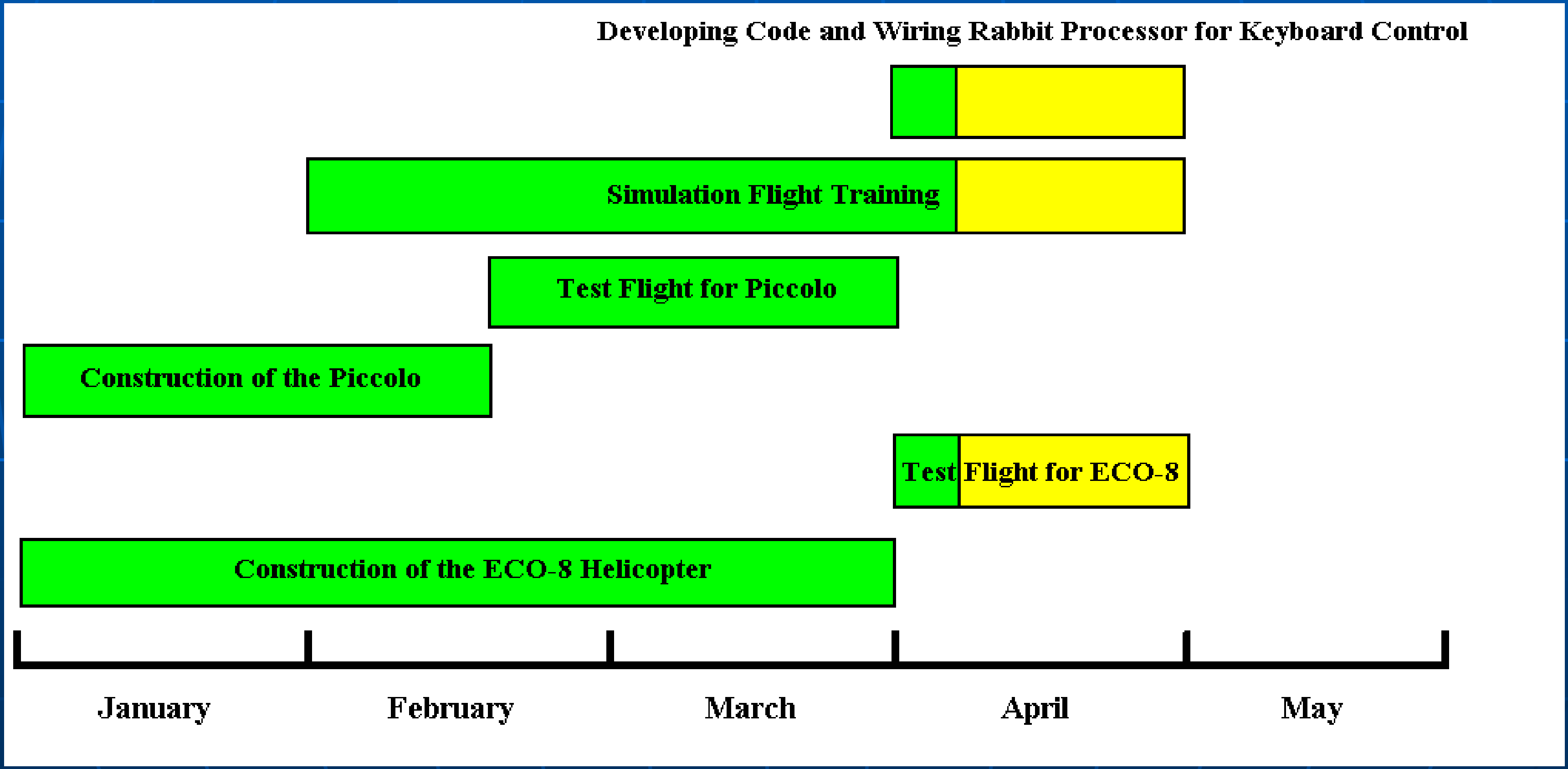
- MATLAB for vision processing
- A GUI template developed for simplified user interface where push-buttons can initiate processing
- Vision Processing Examples:

noise filters, brighten/darken, sharpen, image/target recognition

Resultant Surveillance Helicopter ECO 8

- Successful prototype helicopter with camera mounted without affecting the flight dynamics
- Simplified passage of flight control to secondary user
- A simulation model of the helicopter system in the design phase (to improve control)

2003 USNA Project Timeline (snapshot at Critical Deign Review)



Project Goals

- Current Goal
  - Limited flight ability with joystick or keys from laptop
- Final Project
  - Ability to fly stability augmented Helicopter with only a laptop or PDA

Future Additions

- Additional Camera
  - Improved flight awareness
    - Object avoidance
  - Adaptable to different lenses
    - Zoom
    - Night Vision
  - Better surveillance capability
  - No additional modeling required
- Pitch/Roll Stabilization
  - AutoPilot IR Controller (installed)
- Ranging Sensors
- GPS Transmitter (fixed wing prototype)
  - X-, Y- coordinates and altitude
  - Gives feedback for simplified control
- Issues
  - Weight
  - Power requirements

Stability Augmentation

Flight Test Results

Questions?